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Spectrochimica Acta Part B 50 (1995) 1847–1867

SPECTROCHIMICA ACTA PART B

Mechanism of aluminium spike formation and dissipation in electrothermal atomic absorption spectrometry

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Received 9 December 1994; accepted 23 May 1995

Abstract

The mechanism of aluminium spike formation and dissipation of aluminium atoms in electrothermal atomization absorption spectrometry has been investigated using two different approaches. The first approach employs a graphite electrothermal atomizer coupled to an inductively coupled plasma mass spectrometer (ICP–MS) in a configuration that allows simultaneous measurement of atomic, or molecular, absorption signals and mass spectrometric signals. Aluminium sub-oxide (AlO and Al_2O) and CO(g) spikes in ICP–MS are correlated with the appearance of both Al atom spikes and Al-containing molecule spikes in absorption spectrometry. The aluminium carbide (AlC_2) signal in ICP–MS is not coincident with the appearance of either Al atom spikes or Al-containing molecule spikes in absorption spectrometry. The second approach uses two different imaging systems, i.e. shadow spectral filming (SSF) and shadow spectral digital imaging (SSDI), to provide temporally and spatially resolved absorption profiles of Al atoms and Al-containing molecules during Al spike formation and dissipation. The transverse cross-sectional distribution of Al atoms and of Al-containing molecules in the graphite furnace are complementary to one another for both wall and platform atomization. The highest concentration of Al atoms is near the graphite surface, whereas the highest concentration of Al-containing molecular species is at the centre of the graphite tube. The Al-containing molecules observed in both wall and platform atomization consist of both gaseous Al-molecules and a non-uniformly distributed cloud of finely dispersed Al_2O_3(s,l) particles. A mechanism of formation that is consistent with the above experimental observations is presented. It is proposed that Al atom spikes are formed from gaseous Al_2O precursors and that this reaction is triggered by the formation of a molten, condensed-phase Al_4C_3 melt.

Keywords: Aluminium spike formation; Electrothermal atomic absorption spectrometry

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SSDI 0584-8547(95)01367-9